MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2018

October–December 2018—Volume 133, pp. 655–674

https://doi.org/10.5248/133.655

Eighteen species of *Graphidaceae* new to Nepal

Neena Karmacharya[1*], Santosh Joshi[2],
Dalip K. Upreti[3], Mukesh K. Chettri[4]

[1] *Botany Department, Padma Kanya Multiple Campus, Tribhuvan University, Kathmandu, Nepal*
[2] *Department of Applied Science and Humanities, Invertis University, Bareilly (UP), India*
[3] *Lichenology laboratory, CSIR-National Botanical Research Institute, Lucknow (UP), India*
[4] *Botany Department, Amrit Campus, Tribhuvan University, Lainchaur, Kathmandu, Nepal*

* Correspondence to: *karmacharya129@gmail.com*

Abstract—Eighteen graphidoid lichen species in *Diorygma, Graphis, Pallidogramme,* and *Phaeographis* are reported as new records from Nepal. Diagnostic characters of each species are discussed and supported by chemistry, ecology, and distribution. An identification key is provided to the 24 graphidaceous species recorded from Nepal.

Key words—Kathmandu, lichenized fungi, lirellate, taxonomy

Introduction

Molecular studies have provided a broad framework for *Graphidaceae* and produced numerous nomenclatural changes and rearrangements. These have resulted in the fusion of several concepts, with some old or obsolete taxa resurrected and many new taxa described (Staiger & Kalb 1999; Staiger 2002; Staiger & al. 2006; Lücking & al. 2009, 2013; Mangold & al. 2008, 2009; Rivas Plata & Lumbsch 2011, Rivas Plata & al. 2012a,b, 2013; Kraichak & al. 2014; Lumbsch & al. 2014a,b). As currently accepted, *Graphidaceae* represents the second largest lichen family, with 2161 species distributed among 79 genera (Lücking & al. 2017).

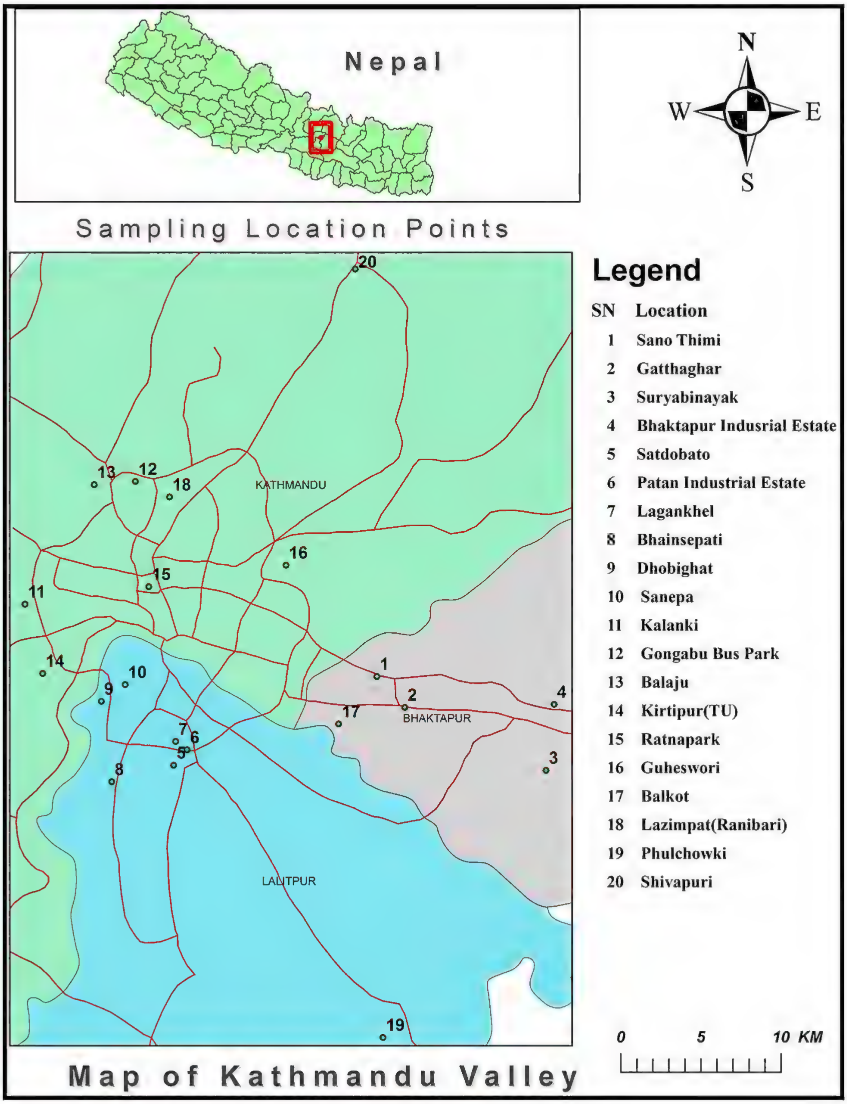
Lichenological studies in Nepal have been conducted by primarily western and a few native lichenologists (Lamb 1966; Bystrek 1969; Abbayes 1974; Poelt 1974; Jahns & Seelen 1974; Kurokawa 1974; Mitchell 1974; Schmidt 1974; Vězda & Poelt 1975; Awasthi 1986, 1991, 2007; Awasthi & Mathur 1987; Sharma 1995; Baniya & al. 2001; Olley & Sharma 2013), and a total of 820 species of lichenized-fungi have been recorded from the country (Olley & Sharma 2013, Rai et al 2016). However, the crustose lichens have been little studied, particularly the family *Graphidaceae* with lirellate taxa, for which only six species—*Glyphis cicatricosa* Ach., *Graphis chlorotica* A. Massal., *G. proserpens* Vain., *G. scripta* (L.) Ach., *G. tenella* Ach., and *Platythecium pyrrhochroum* (Mont. & Bosch.) Z.F. Jia & Lücking—have been recorded from Nepal (Olley 2008, Olley & Sharma 2013, Rai & al. 2016). The present study covers species of graphidoid (lirellate) lichens collected from central Nepal and reported as new to the country.

Including the 18 new records described in this paper, 24 species in *Graphidaceae* are now known from Nepal. We refrain from including *Phaeographina nepalensis* D.D. Awasthi & Kr.P. Singh described from Nepal (Awasthi & Singh 1973), because its identity is uncertain; it may represent a *Graphis* species with striate labia, although brown ascospores are rare in the genus. Two other names previously reported from Nepal are included as synonyms: *Graphis subglauconigra* Nagarkar & Patw. has been synonymised with *G. tenella* (Lücking & al. 2009); and *Phaeographina pyrrhochroa* is a homotypic synonym of the new combination *Platythecium pyrrhochroum* (Jia & Lücking 2017). Three newly reported species extend across Asia from the Neotropics to the Eastern Palaeotropics. The amount of interesting material in our collections suggests an extraordinary diversity of *Graphidaceae* in Nepal and indicates the need for further lichenological investigations in unexplored areas of the country.

Materials & methods

The study sites were located in different areas around Kathmandu Valley in the Bagmati Zone of Central Nepal (Map 1). The valley is roughly 650 km^2 with elongated east west; its average elevation is c. 1350 m and annual precipitation averages 1343 mm (Shakya & al. 2014).

Initially, a GIS based sampling map of Kathmandu was designated (MAP 1) to locate the 20 study sites. Samples were collected from all the sites based on availability of lichens on barks. The collected material was processed for curation using standard lichenological procedures (Awasthi 2000), and the voucher specimens



Map 1. Sampling areas in the Kathmandu Valley of Nepal.

were deposited at the National Herbarium Laboratory, Godavari, Kathmandu, Nepal (KATH). Specimens were examined and identified at the Lichenology laboratory, CSIR-National Botanical Research Institute, Lucknow, India. Diagnostic characters were observed with standard light microscopy techniques using a LEICA™ S8APO stereomicroscope and LEICA™ DM500 optical microscope. Thallus and ascocarp sections were mounted in water, 10% KOH, and lactophenol blue; Lugol's solution was used to check amyloidity (I+ or I–). All measurements were made in water. Chemical constituents were identified by spot color reaction tests and thin layer chromatography (TLC; solvent system A) following published protocols (Elix & Ernst-Russel 1993, Orange & al. 2001). Measurements of hymenium, exciple, asci, and ascospores (5-10 ascospores measured per sample) were made on 5–10 thin, hand-cut apothecial sections per collection. Specimen identifications, nomenclatural changes, and new records were validated against relevant keys, monographs, and checklists (Archer 2005; Lücking & al. 2009; Singh & Sinha 2010; Joshi et al. 2013a,b; Olley & al. 2013; Mishra & al. 2016). Terms used to define lirellae morphs follow Lücking & al. (2009).

Taxonomy

Diorygma hieroglyphicum (Pers.) Staiger & Kalb,
Symb. Bot. Upsal. 34(1): 151, 2004. PL. 1A

Thallus corticolous, crustose, greenish-white, smooth to uneven, 120–140 µm thick; photobiont *Trentepohlia*; ascomata lirellate, lirellae emergent to semi-emergent, white, straight to curved, simple to branched, 2.0–3.5 × 0.3–0.5 mm, with indistinct thalline margin; disc broad, concealed, flat to concave, white pruinose, 0.2–0.4 mm in diam.; proper exciple hyaline to pale-brown, divergent, poorly developed; hymenium hyaline, clear; asci 1-spored; ascospores hyaline, amyloid (I+ blue), muriform, with unequal locules, 95–150 × 30–40 µm.

CHEMISTRY—Thallus K+ yellow orange, Pd+ reddish, C–, KC–. Stictic acid detected with TLC.

ECOLOGY—*Diorygma hieroglyphicum* was found growing on the barks of *Alnus nepalensis* D. Don (*Betulaceae*) and *Castanopsis indica* (Roxb. ex Lindl.) A. DC. (*Fagaceae*) at 1600–1900 m near the buffer zone of Shivapuri National Park and of Phulchowki forest area.

SPECIMENS EXAMINED – **NEPAL. BAGMATI ZONE:** Shivapuri National Park, 27°35′05″N 85°22′42″E, alt. 1626 m, on tree bark, 1 December 2016, Neena Karmacharya 16–134 (KATH); Phulchowki, 27°34′47″N 85°23′09″E, alt. 1936 m, on tree bark, 1 December 2016, Neena Karmacharya 16–148 (KATH).

COMMENTS—Our Nepalese specimens corresponded closely to previously published descriptions of *D. hieroglyphicum.* This pantropical species has been recorded in Nepal, India, Vietnam, Australia, Cameroon, New Caledonia, Tanzania, Indonesia, Singapore, Papua New Guinea, the Philippines, Vanuatu, and the Solomon Islands (Archer 2009, Kalb & al. 2004, Joshi & al. 2013a).

Diorygma junghuhnii (Mont. & Bosch.) Kalb, Staiger & Elix,
Symb. Bot. Upsal. 34(1): 157, 2004. Pl. 1b

Thallus corticolous, crustose, white, creamy, pale-gray or greenish-gray, rough, dull, 75–90 µm thick; photobiont *Trentepohlia;* ascomata lirellate, lirellae emergent, curved, simple to branched 2–3.5 × 0.5–1 mm with crenate thalline margin; disc concealed, brown to dark brown, white pruinose; proper exciple hyaline to pale-brown, slightly divergent, poorly developed; hymenium hyaline, clear; asci 1–2-spored; ascospores hyaline, amyloid (I+ violet-blue), muriform (25–31 × 6–10 locular) measuring 84–134 × 29–42 µm.

Chemistry—Thallus K+ yellow orange, Pd+ yellow-orange, C–, KC–. Norstictic and constictic acids detected with TLC.

Ecology—*Diorygma junghuhnii* was collected with many other members of *Parmeliaceae* and *Physciaceae* at c. 1600 m in the Phulchowki forest area.

Specimen examined – **NEPAL. Bagmati zone:** Phulchowki, 27°35′05″N 85°22′42″E, alt. 1626 m, on tree bark, 19 December 2016, Neena Karmacharya 16–089A (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *D. junghuhnii,* the most common *Diorygma* species. This pantropical species has previously been reported from India, China, Vietnam, Japan, the Philippines, Indonesia, Australia, New Caledonia, Tanzania, Brazil, Costa Rica, Guatemala, Paraguay, Solomon Islands, Tahiti, and Thailand (Kalb & al. 2004, Joshi & al. 2013b).

Graphis antillarum Vain., Hedwigia 38: 255, 1899. Pl. 1c

Thallus corticolous, crustose, whitish-gray, rough; photobiont *Trentepohlia;* ascomata lirellate, lirellae appear whitish-gray due to broken thalline cover studded in furrows of labia, erumpent, elongate, curved, simple to irregularly branched (*tenella*-morph), 2–8 × 0.2 mm in size with thick lateral thalline margin; labia striate; proper exciple laterally carbonized; hymenium hyaline, clear; asci 2–8-spored; ascospores hyaline, amyloid (I+ blue), muriform, 30–60 × 17–25 µm.

Chemistry—Thallus K+ yellow turning red, Pd+ yellow-orange, C–, KC–; norstictic acid detected with TLC.

Ecology—*Graphis antillarum* was collected from the bark of *Rhododendron* spp. (*Ericaceae*) in the Shivapuri National Park at c. 1800 m.

Specimen Examined – **NEPAL. Bagmati zone:** Shivapuri National Park, 27°46′49″N 85°22′56″E, alt. 1875 m, on tree bark, 11 February 2017, Neena Karmacharya 17–207C (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. antillarum*. This cosmopolitan species was previously reported from Germany and Costa Rica (Lücking & al. 2008, 2009).

Graphis breussii G. Neuwirth & Lücking, Lichenologist 41: 272, 2009. Pl. 1d

Thallus corticolous, crustose, rough, gray to whitish-gray with dull surface; photobiont *Trentepohlia;* ascomata lirellate, lirellae elongate, curved, prominent, simple to irregularly branched (*acharii*-morph), 6–10 × 0.3–0.5 mm, with apically thin complete and conspicuous thalline margin; labia striate, convergent; proper exciple completely carbonized, deeply incised with thalline cover; hymenium hyaline, clear; asci 4-spored; ascospores hyaline, muriform (7–11 × 1–2 locular), amyloid (I+ blue-violet), 30–45 × 9–12 μm.

Chemistry—Thallus K+ yellow turning red, Pd+ yellow-orange, C–, KC–. Norstictic acid detected with TLC.

Ecology—*Graphis breussii* was found growing among other foliose and crustose lichens on bark of *Alnus nepalensis* and collected from Phulchowki at c. 1600 m.

Specimen examined – **NEPAL. Bagmati zone:** Phulchowki, 27°35′05″N 85°22′42″E, alt. 1626 m, on tree bark, 19 December 2016, Neena Karmacharya 16–093C (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. breussii*. This new continental record was previously known from southern Venezuela (Lücking & al. 2009).

Graphis cincta (Pers.) Aptroot, Fl. Australia 57: 651, 2009. Pl. 1e

Thallus corticolous, crustose, off-white to pale-fawn, smooth, dull; photobiont *Trentepohlia;* ascomata lirellate, lirellae erumpent, numerous, scattered, elongate, straight to curved or sinuous, simple, 0.5–2.0 × 0.1–0.2 mm, with a conspicuous basal to lateral thalline margin (*lineola*-morph); disc concealed, rarely slightly open; labia entire; proper exciple laterally carbonized; hymenium hyaline, inspersed with oil droplets; asci 8-spored; ascospores hyaline, amyloid (I+ blue), transversely 7–11-septate, measuring 25–40 × 7–10 μm.

Chemistry—Thallus K+ yellow turning red, Pd+ yellow-orange, C–, KC–. Norstictic acid detected with TLC.

Ecology—*Graphis cincta* was collected from the bark of *Cinnamomum camphora* (L.) J. Presl (*Lauraceae*) near industrial site of Balaju in Kathmandu Valley at c. 1300 m.

Specimen examined – **NEPAL. Bagmati zone:** Balaju, 27°44′01″N 85°18′02″E, alt. 1310 m, on tree bark, 11 November 2016, Neena Karmacharya 16–046A (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. cincta.* It has a pantropical distribution and was previously reported from India, Australia, Paraguay, the Philippines, Taiwan, West Indies, Costa Rica, Japan, and Vanuatu (Singh & Sinha 2010; Archer 2009; Lücking & al. 2008, 2009).

Graphis cleistoblephara Nyl., Ann. Sci. Nat., Bot., Sér. 4, 20: 265, 1863. Pl. 1f

Thallus corticolous, crustose, gray to pale-gray, fawn colored, thin, smooth, dull; photobiont *Trentepohlia;* ascomata lirellate, lirellae erumpent, conspicuous, numerous, scattered, very short, unbranched, sessile, straight, 0.5–0.2 × 0.3–0.5 mm, with a thick conspicuous lateral thalline margin (*dussii*-morph); disc concealed; labia entire; proper exciple completely carbonized; hymenium: hyaline, clear; asci 2–4-spored; ascospores hyaline, amyloid (I+ blue), muriform (19–23 × 2–5 locular) measuring 85–120 × 15–20 µm.

Chemistry—Thallus K+ yellow turning red, Pd+ yellow-orange, C–, KC–. Norstictic acid detected with TLC.

Ecology—*Graphis cleistoblephara* occurs most commonly on the bark of *Acer oblongum* Wall. ex DC. (*Aceraceae*) at c. 1300 m in the Ranibari area of Kathmandu.

Specimen examined – **NEPAL. Bagmati zone:** Ranibari, 27°43′49″N 85°19′15″E, alt. 1326 m, on tree bark, 13 October 2016, Neena Karmacharya 16–016 (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. cleistoblephara.* The pantropical species has been recorded from India, Australia, China, Indonesia, Japan, Mexico, the Philippines, and Sri Lanka (Lücking & al. 2009, Singh & Sinha 2010).

Graphis galactoderma (Zahlbr.) Lücking, Lichenologist 41: 436, 2009. Pl. 1g

Thallus corticolous, crustose, white to pale-yellow, smooth to cracked; photobiont *Trentepohlia;* ascomata lirellate, lirellae erumpent to prominent, crowded, curved, simple to sparsely branched, 3–6 × 0.2 mm, with lateral thalline margin (*lineola*-morph); labia 1–4 striate; proper exciple apically (to peripherally) carbonized; hymenium hyaline, clear; asci 8-spored; ascospores hyaline, amyloid (I+ blue), muriform, 20–45 × 9–16 µm.

Chemistry—Thallus K+ yellowish, Pd+ orange, C–, KC–. Stictic acid detected with TLC.

Ecology—*Graphis galactoderma* was common among the *Quercus semecarpifolia* Sm. (*Fagaceae*) forest area in Phulchowki forest area above 2000 m.

> Specimen examined – **NEPAL. Bagmati zone:** Phulchowki, 27°34′46″N 85°23′31″E, alt. 2156 m, on tree bark, 04 February 2017, Neena Karmacharya 17–158B (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. galactoderma.* The species is common in eastern paleotropics and has been recorded from the tropical regions of India and China (Lücking & al. 2009, Archer 2009).

Graphis leprographa Nyl., Acta Soc. Sci. Fenn. 26(10): 21, 1900. Pl. 1h

Thallus corticolous, crustose, white to yellowish-gray, smooth to uneven; photobiont *Trentepohlia;* ascomata lirellate, lirellae prominent, simple, crowded, very short, unbranched with thick lateral thalline margin (*dussii*-morph); labia entire; proper exciple completely carbonized; hymenium hyaline, clear; asci 1–2-spored; ascospores hyaline, amyloid (I+ blue), muriform, 60–110 × 15–30 µm.

Chemistry—Thallus K+ yellow turning red, Pd+ yellow-orange, C–, KC–. Norstictic acid detected with TLC.

Ecology—*Graphis leptographa* was found growing in association with some leprose taxa and collected from the bark of *Alnus nepalensis* at c. 1600 m in the buffer zone of the Shivapuri National Park.

> Specimen examined – **NEPAL. Bagmati zone:** Shivapuri National Park, 27°47′30″N 85°22′15″E, alt. 1647 m, on tree bark, 19 December 2016, Neena Karmacharya 16–133A/c (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. leptographa.* It has pantropical distribution and recorded previously from Sri Lanka, Costa Rica, and Seychelles (Lücking & al. 2008, 2009).

Graphis lineola Ach., Lich. Univ.: 264, 1810. Pl. 1i

Thallus corticolous, crustose, whitish-gray, smooth, dull; photobiont *Trentepohlia*; ascomata lirellate, lirellae erumpent, numerous, simple to sparsely branched with lateral thalline margin (*lineola*-morph), 0.5–3 × 0.1–0.3 mm; disc concealed; labia entire; proper exciple laterally carbonized; hymenium hyaline, inspersed with oil-droplets; asci 8-spored; ascospores hyaline, amyloid (I+ blue), transversely 5–11-septate, 60–110 × 15–30 µm.

Chemistry—Thallus K–, Pd–, C–, KC–. No substances detected with TLC.

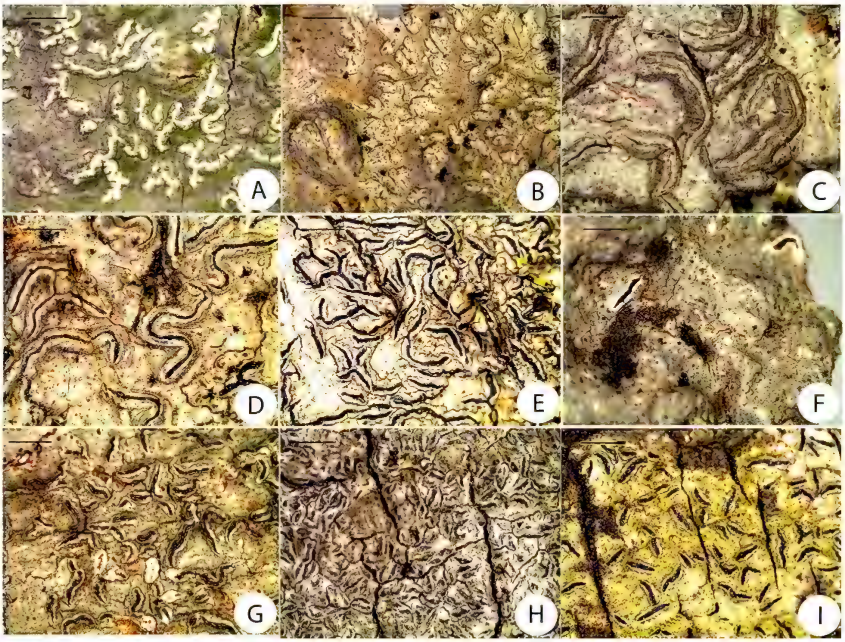


Plate 1. New records in *Graphidaceae* from Nepal. A. *Diorygma hieroglyphicum*; B. *D. junghuhnii*; C. *Graphis antillarum*; D. *G. breussii*; E. *G. cincta*; F. *G. cleistoblephara*; G. *G. galactoderma*; H. *G. leprographa*; I. *G. lineola*. Scale bars: A, B, G = 2 mm; C–F, H, I = 1 mm.

Ecology—*Graphis lineola* was collected from the bark of *Pinus roxburghii* Sarg. (*Pinaceae*) growing along the roadside at c. 1300 m in the Bhaisepati area of Kathmandu.

Specimen examined – **NEPAL. Bagmati zone:** Bhaisepati, 27°39′13″N 85°18′19″E, alt. 1344 m, on tree bark, 24 November 2016, Neena Karmacharya 16–109B (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. lineola,* which occurs commonly in the tropics and has been recorded from India, China, Costa Rica, Taiwan, West Indies, and Portugal (Lücking & al. 2009, Singh & Sinha 2010, Lepista & Aptroot 2016).

Graphis paradisserpens Sipman & Lücking, Fieldiana, Bot. 46: 96, 2008. Pl. 2a

Thallus corticolous, crustose, creamy white to pale-gray, smooth to uneven, dull; photobiont *Trentepohlia;* ascomata lirellate, lirellae erumpent, very long, curved, radiately branched, 2–8 × 0.2–0.3 mm, lacking or with basal thalline margin (*sorediosa*-morph); disc concealed; labia striate; proper exciple apically (to peripherally) carbonized; hymenium hyaline, clear; asci 2–8-spored; ascospores hyaline, amyloid (I+ blue), submuriform (5–7 × 0–2 locular), 25–40 × 8–15 µm.

Chemistry—Thallus K–, Pd–, C–, KC–. No substances detected with TLC.

Ecology—*Graphis paradisserpens* was collected from the bark of *Alnus nepalensis* at c. 1600 m in the Phulchowki forest area.

Specimen examined – **NEPAL. Bagmati zone:** Phulchowki, 27°35′05″N 85°22′42″E, alt. 1626 m, on tree bark, 16 December 2016, Neena Karmacharya 16–093A/a (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. paradisserpens*. The species was previously reported from the neotropical regions of Costa Rica and the West Indies (Lücking & al. 2009). Our report represents a new record for Asia.

Graphis paraserpens Lizano & Lücking, Fieldiana, Bot. 46: 96, 2008. Pl. 2b

Thallus corticolous, crustose, gray to pale-gray, smooth to uneven; photobiont *Trentepohlia;* ascomata lirellate, lirellae emerged to erumpent, elongate, straight to flexuose, simple to irregularly branched with apically thin complete thalline margin (*symplecta*-morph), 2–5 × 0.2–0.3 mm; disc concealed; labia striate; proper exciple apically (to peripherally) carbonized; hymenium hyaline, clear; asci 2–6-spored; ascospores hyaline, amyloid (I+ blue), muriform, 30–40 × 9–12 µm.

Chemistry—Thallus K–, Pd–, C–, KC–. No substances detected with TLC.

Ecology—*Graphis paraserpens* was collected from the bark of *Schima wallichii* Choisy (*Theaceae*) at c. 1700 m in the forested area of Shivapuri National Park.

Specimen examined – **NEPAL. Bagmati zone:** Shivapuri National Park, 27°47′27″N 85°22′23″E, alt. 1706 m, on tree bark, 11 February 2017, Neena Karmacharya 16–182 (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. paraserpens*. The species is new to palaeotropical region and has been reported from Brazil and Costa Rica (Lücking & al. 2008, 2009).

Graphis pertricosa (Kremp.) A.W. Archer, Telopea 11: 73, 2005. Pl. 2c

Thallus corticolous, crustose, off-white to fawn, smooth to verrucose, dull; photobiont *Trentepohlia;* ascomata lirellate, lirellae erumpent, straight to curved or sinuous, numerous, scattered, short and simple to sparsely branched with apically thin complete thalline margin (*negrosina*-morph), 1–2.5 × 0.1–0.3 mm; disc concealed; labia entire; proper exciple laterally carbonized; hymenium hyaline, inspersed with oil-droplets; asci 8-spored; ascospores hyaline, amyloid (I+ blue), muriform (6–9× 1–3 locular), 25–40 × 8–12 µm.

CHEMISTRY—Thallus K+ yellow turning red, Pd+ reddish, C–, KC–. Norstictic acid detected with TLC.

ECOLOGY—*Graphis pertricosa* was common on the bark of *Castanopsis indica* at c. 2000 m in the valley of the Phulchowki forest area.

SPECIMEN EXAMINED – **NEPAL. BAGMATI ZONE:** Phulchowki, 27°34′46″N 85°23′31″E, alt. 2156 m, on tree bark, 24 February 2017, Neena Karmacharya 16–163A (KATH).

COMMENTS—Our Nepalese specimen corresponded closely to previously published descriptions of *G. pertricosa.* The species is common in eastern palaeotropical countries including Australia (Lücking & al. 2009) and has also been reported from India, Indonesia, Malaysia, and Tanzania (Archer 2009, Singh & Sinha 2010).

Graphis pinicola Zahlbr., Symb. Sin. 3: 43, 1930. PL. 2D

Thallus corticolous, crustose, white to whitish-gray, smooth to verrucose; photobiont *Trentepohlia;* ascomata lirellate, lirellae erumpent to prominent, short to elongate, straight to curved, sparsely and irregularly or branched with lateral thalline margin (*lineola*- or *deserpens*-morph), 1–4 × 0.1–0.3 mm; disc concealed; labia entire; proper exciple laterally carbonized; hymenium hyaline, clear; asci 8-spored; ascospores hyaline, amyloid (I+ blue), transversely 8–10-septate, 25–35 × 10–12 µm.

CHEMISTRY—Thallus K–, Pd–, C–, KC–. No substances detected with TLC.

ECOLOGY—*Graphis pinicola* was collected from the bark of *Schima wallichii*, where it was growing in association with *Graphis paraserpens* and other corticolous lichenized and non-lichenized fungi at c. 1700 m in the Shivapuri National Park of Kathmandu.

SPECIMEN EXAMINED – **NEPAL. BAGMATI ZONE:** Shivapuri National Park, 27°47′27″N 85°22′23″E, alt. 1706 m, on tree bark, 11 February 2017, Neena Karmacharya 17–200A (KATH).

COMMENTS—Our Nepalese specimen corresponded closely to previously published descriptions of *G. pinicola.* The pantropical species has been reported also from India, China, Bolivia, and Thailand (Lücking & al. 2009, Singh & Sinha 2010).

Graphis stenotera Vain., Ann. Acad. Sci. Fenn., Ser. A, 15: 243, 1921. Pl. 2E

Thallus corticolous, crustose, off-white to whitish-gray, smooth, dull, slightly rimose; photobiont *Trentepohlia;* ascomata lirellate, lirellae erumpent to prominent, scattered, straight, curved to sinuous, simple to sparsely branched lacking lateral thalline margin, 1–3 × 0.15–0.3 mm; disc concealed; labia striate (*striatula*-morph), non-pruinose; proper exciple apically carbonized; hymenium hyaline, clear; asci 8-spored; ascospores hyaline, amyloid (I+ blue), transversely 6–9-septate, 20–35 × 6–9 µm.

Chemistry—Thallus K+ yellow, Pd+ yellowish, C–, KC–. Stictic acid detected with TLC.

Ecology— *Graphis stenotera* was collected from the bark of *Alnus nepalensis* at c. 1600 m in the Phulchowki forest area.

Specimen examined – **NEPAL. Bagmati zone:** Phulchowki, 27°35′05″N 85°22′42″E, alt. 1626 m, on tree bark, 19 December 2016, Neena Karmacharya 16–093B (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. stenotera.* The tropical species has been reported from Nepal, India, Costa Rica, the Philippines, and Taiwan (Singh & Sinha 2010).

Graphis subvelata Stirt., Queensland Agric. J. 5: 488, 1899. Pl. 2F

Thallus corticolous, crustose, off-white to whitish-gray, smooth, dull, slightly rimose; photobiont *Trentepohlia;* ascomata lirellate, lirellae erumpent, curved or sinuous, short to elongate, simple to sparsely branched with lateral thalline margin (*lineola*- or *deserpens*-morph), 1–4 × 0.1–0.3 mm; disc concealed; labia entire; proper exciple laterally carbonized; hymenium hyaline, inspersed with oil-droplets; asci 8-spored; ascospores hyaline, amyloid (I+ blue), muriform (5–10 × 1–3 locular), 35–45 × 8–15 µm.

Chemistry—Thallus K–, Pd–, C–, KC–. No substances detected with TLC.

Ecology—*Graphis subvelata* was collected from the bark of *Schima wallichii* in association with other graphidoid lichens at c. 1800 m in Shivapuri National Park in Kathmandu.

Specimen examined – **NEPAL. Bagmati zone:** Shivapuri National Park, 27°47′21″N 85°22′36″E, alt. 1802 m, on tree bark, 11 February 2017, Neena Karmacharya 17–196B (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *G. subvelata.* The species has an eastern palaeotropical distribution in Nepal, New Zealand, the Philippines, Papua New Guinea, Thailand, and Australia (Archer 2009, Lücking & al. 2009).

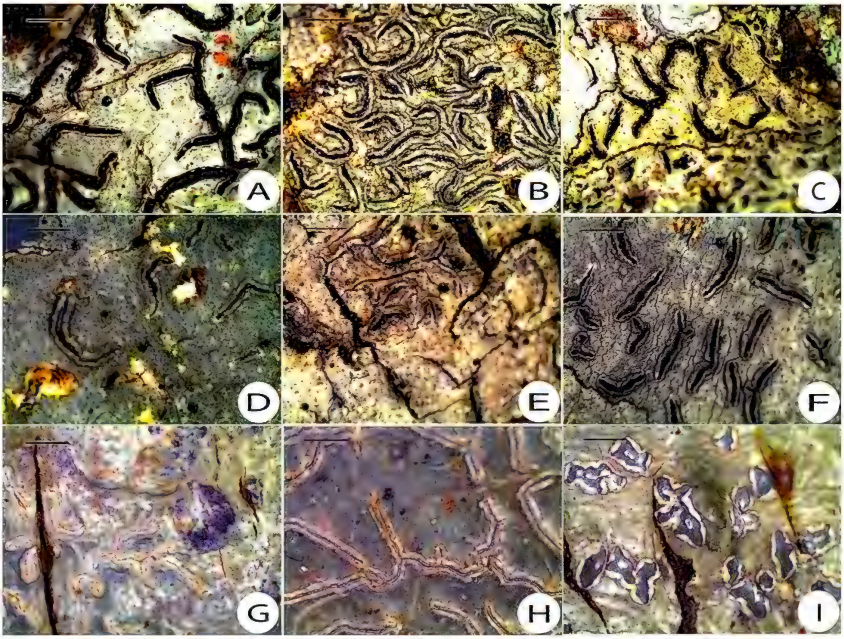


Plate 2. New records in *Graphidaceae* from Nepal. A. *Graphis paradisserpens*; B. *G. paraserpens*; C. *G. pertricosa*; D. *G. pinicola*; E. *G. stenotera*; F. *G. subvelata*; G. *Pallidogramme chrysenteron*; H. *P. divaricoides*; I. *Phaeographis leiogrammodes*. Scale bars = 1 mm.

Pallidogramme chrysenteron (Mont.) Staiger, Kalb & Lücking, Fieldiana, Bot. 46: 9, 2008. Pl. 2G

Thallus corticolous, crustose, off-white to pale-fawn, smooth, dull; photobiont *Trentepohlia;* ascomata lirellate, lirellae sessile, numerous, curved to sinuous, often branched, 1–5 × 0.4–0.6 mm; disc concealed; labia striate; proper exciple fan-shaped, yellowish-brown, convergent; hymenium hyaline, inspersed with oil-droplets; asci 8-spored; ascospores hyaline to pale-brown, non-amyloid (I– or I+ wine red), muriform (9–16 × 1–3 locular), 50–75 × 9–15 µm.

Chemistry—Thallus K+ yellow, Pd+ orange, C–, KC–. Stictic acid detected with TLC.

Ecology—*Pallidogramme chrysenteron* was found growing on the bark of *Rhododendron* spp. (*Ericaceae*) above 2000 m in the Phulchowki forest area.

Specimen examined – **NEPAL. Bagmati zone:** Phulchowki, 27°34′41″N 85°23′40″E, alt. 2240 m, on tree bark, 04 February 2017, Neena Karmacharya 17–163B (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *P. chrysenteron.* The pantropical species has been recorded also from India, Sri Lanka, China, Brazil, Colombia, Costa Rica, Guyana, Panama, Australia, the Philippines, Thailand, and Vietnam (Staiger 2002, Singh & Sinha 2010, Schiefelbein & al. 2014, Joshi & al. 2015).

Pallidogramme divaricoides (Räsänen.) Pushpi Singh & Kr.P. Singh,
Lichenologist 49: 531, 2017. Pl. 2h

Thallus corticolous, crustose, gray to greenish-gray, smooth, dull; photobiont *Trentepohlia;* ascomata lirellate, lirellae erumpent to prominent, curved to sinuous, elongate, divaricately branched, ≤10 mm long; disc concealed; labia striate; proper exciple pale-brown; hymenium hyaline, inspersed with oil-droplets; asci 8-spored; ascospores hyaline, amyloid (I+ blue), transversely 5–11-septate, 25–40 × 7–11 µm.

Chemistry—Thallus K–, Pd–, C–, KC–. No substances detected with TLC.

Ecology—*Pallidogramme divaricoides* was collected from the bark of *Alnus nepalensis* at c. 1600 m in the forest area of Phulchowki.

Specimen examined – **NEPAL. Bagmati zone:**, Phulchowki, 27°35′05″N 85°22′42″E, alt. 1626 m, on tree bark, 19 December 2016, Neena Karmacharya 16–089B (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *P. divaricoides.* It has been also reported from India (Singh & Singh 2017).

Phaeographis leiogrammodes (Kremp.) Müll. Arg.,
Nuovo Giorn. Bot. Ital. 23: 397, 1891. Pl. 2i

Thallus corticolous, crustose, pale to creamy-white, grayish, sometimes concolorous with substratum, smooth to verrucose, continuous; photobiont *Trentepohlia;* ascomata lirellate, lirellae immersed to level with thallus, numerous, simple, short to elongate, sparsely branched, stellate with a prominent thalline margin, 1–3 × 0.1–0.5 mm; disc exposed, concave to flattened, grayish, white pruinose; proper exciple thin, indistinctly present, hyaline to yellowish; hymenium hyaline, clear; asci 8-spored; ascospores brownish, amyloid (I– or I+ wine red), submuriform (8–14 × 1–2 locular µm), ≤40 × 9–15 µm.

Chemistry—Thallus K+ orange-red, Pd+ orange, C–, KC–. Norstictic and stictic acids detected with TLC.

Ecology—*Phaeographis leiogrammodes* was collected in association with other graphidoid species from the bark of *Castanopsis indica* at c. 1800 m from Shivapuri National Park in Kathmandu.

Specimen examined – **NEPAL. Bagmati zone:** Shivapuri National Park, 27°47′21″N 85°22′36″E, alt. 1802 m, on tree bark, 11 February 2017, Neena Karmacharya 17–196A (KATH).

Comments—Our Nepalese specimen corresponded closely to previously published descriptions of *P. leiogrammodes*. The pantropical species has been recorded also from China, Costa Rica, Thailand, Ecuador, and Netherlands (Staiger 2002, Aptroot & al. 2007, Bungartz & al. 2010).

Key to the species of *Graphidaceae* recorded from Nepal

1. Proper exciple hyaline to brown, not carbonized 2
1. Proper exciple distinctly carbonized, at least in some parts 7

2. Hymenium clear 3
2. Hymenium inspersed with oil-droplets 6

3. Disc concealed;
asci 2–4-spored; ascospores brownish, 28–60 × 10–17 µm;
norstictic acid .... ***Platythecium pyrrhochroum*** [≡ *Phaeographina pyrrhochroa*]
3. Disc broadly exposed 4

4. Asci 1-spored; ascospores muriform, hyaline, 95–150 × 30–40 µm;
stictic acid .... ***Diorygma hieroglyphicum***
4. Asci 1–8-spored; ascospores sub-muriform to muriform, hyaline to brown;
norstictic and/or stictic acids 5

5. Asci 1–2-spored; ascospores muriform, hyaline, 84–134 × 29–42 µm,
norstictic acid .... ***Diorygma junghuhnii***
5. Ascospores 8-spored; ascospores sub-muriform, brownish, ≤40 × 9–15 µm,
norstictic and stictic acids .... ***Phaeographis leiogrammodes***

6. Lirellae prominent to erumpent, divaricately branched;
ascospores transversely septate, hyaline, 25–40 × 7–11 µm;
no substances .... ***Pallidogramme divaricoides***
6. Lirellae sessile, irregularly branched, often aggregate;
ascospores muriform, hyaline to pale-brown, 50–75 × 9–15 µm;
stictic acid .... ***Pallidogramme chrysenteron***

7. Ascomata embedded in distinctly raised structures (stromata)
on thallus; ascospores transversely septate, 28–60 × 7–10 µm; no
substances .... ***Glyphis cicatricosa***
7. Ascomata not embedded in stromata, solitary to aggregate;
ascospores transversely septate to muriform; substances present or absent 8

8. Labia entire 9
8. Labia striate 16

9. Proper exciple laterally carbonized 10
9. Proper exciple completely carbonized 15

10. Hymenium clear 11

10. Hymenium inspersed with oil-droplets 13

11. Ascospores muriform, 20–40 × 8–12 µm; lirellae with apically thin, complete thalline margin; norstictic acid ...... ***Graphis pertricosa***

11. Ascospores transversely septate 12

12. Disc partly exposed, thinly white pruinose; lirellae with lateral to complete thalline margin; ascospores, 25–60 × 7–9 µm; no substances .... ***Graphis scripta***

12. Disc concealed; lirellae with lateral thalline margin; ascospores 25–35 × 10–12 µm; no substances .... ***Graphis pinicola***

13. Ascospores muriform, 35–50 × 8–15 µm; lirellae with lateral thalline margin; no substances .... ***Graphis subvelata***

13. Ascospores transversely septate 14

14. Norstictic acid; lirellae with basal to lateral thalline margin; ascospores 25–40 × 7–10 µm .... ***Graphis cincta***

14. No substances; lirellae with lateral thalline margin; ascospores 20–40 × 6–9 µm .... ***Graphis lineola***

15. Hymenium clear; lirellae sessile with thick lateral thalline margin; ascospores muriform, 85–120 × 15–20 µm .... ***Graphis cleistoblephara***

15. Hymenium inspersed with oil-droplets; lirellae prominent with thick lateral thalline margin; ascospores muriform 60–110 × 15–30 µm .. ***Graphis leprographa***

16. Proper exciple apically (to peripherally) carbonized 17

16. Proper exciple laterally or completely carbonized 23

17. Ascospores transversely septate 18

17. Ascospores muriform 20

18. Stictic acid; lirellae lacking thalline margin; ascospores 20–35 × 6–9 µm .... ***Graphis stenotera***

18. No substances 19

19. Lirellae with lateral thalline margin; ascospores 28–45 × 5–8 µm .... ***Graphis chlorotica***

19. Lirellae lacking or with basal thalline margin; ascospores 20–48 × 5–8 µm .... ***Graphis proserpens***

20. Norstictic or stictic acids 21

20. No substances 22

21. Norstictic acid; lirellae erumpent with lateral thalline margin; ascospores 30–60 × 17–25 µm .... ***Graphis antillarum***

21. Stictic acid; lirellae erumpent to prominent with lateral thalline margin; ascospores 20–45 × 9–16 µm .... ***Graphis galactoderma***

22. Lirellae radiately branched, lacking or with basal thalline margin; ascospores 25–40 × 8–15 µm .... ***Graphis paradisserpens***

22. Lirellae irregularly branched with apically thin complete thalline margin; ascospores 30–40 × 9–12 µm .... ***Graphis paraserpens***

23. Proper exciple laterally carbonized; lirellae with lateral thalline margin; ascospores transversely septate, 20–35 × 5–7 µm;
no substances . . . . **Graphis tenella** [= ***G. subglauconigra***]

23. Proper exciple completely carbonized; lirellae with apically thin complete thalline margin; ascospores muriform, 30–45 × 9–12 µm;
norstictic acid . . . . **Graphis breussii**

Acknowledgments

Neena Karmacharya is thankful to the University Grant Commission, Kathmandu, Nepal for the award of PhD, and Nepal Association of Science and Technology (NAST) and Indian National Science and Technology (INSA) for providing financial support to visit CSIR-National Botanical Research Institute (Lucknow, India). The Amrit Campus (Kathmandu, Nepal) and CSIR-National Botanical Research Institute (Lucknow) are also thanked for providing laboratory facilities for lichen identification. The authors are grateful to the reviewers Dr. Sanjeeva Nayaka (Lichenology Laboratory, CSIR-National Botanical Research Institute, Lucknow, India) and Dr. Pradeep K. Divakar (Departamento de Biologia Vegetal II, Universidad Complutense de Madrid, Spain) for their valuable comments on manuscript.

Literature cited

Abbayes HD. 1974. *Cladonia* du Nepal. 111–116, in: W Hellmich, J Poelt (eds). Khumbu Himal 6. München: Universitätsverlag Wagner Ges. MBH, Innsbruck.

Aptroot A, Saipunkaew W, Sipman HJM, Sparrius LB, Wolseley PA. 2007. New lichens from Thailand, mainly microlichens from Chiang Mai. Fungal Diversity 24: 75–134.

Archer AW. 2005. New combinations and synonymies in the Australian *Graphidaceae*. Telopea 11: 59–78.

Archer AW. 2009. *Graphidaceae*. In: PM McCarthy (ed.). Flora of Australia, Canberra & Melbourne: ABRS/CSIRO 57: 84–194.

Awasthi G. 1986. Lichen genus *Usnea* in India. Journal of the Hattori Botanical Laboratory 61: 333–421.

Awasthi DD. 1991. A key to the microlichens of India, Nepal and Sri Lanka. Bibliotheca Lichenologica 40. 337 p.

Awasthi DD. 2000. A hand book of lichens, Bishen Singh Mahendra Pal Singh, Dehradun: India.

Awasthi DD. 2007. A compendium of the macrolichens from India, Nepal and Sri Lanka. Bishen Singh & Mahendra Pal Singh, Dehra Dun.

Awasthi DD, Mathur R. 1987. Species of the lichen genera *Bacidia, Badimia, Fellhanera* and *Mycobilimbia* from India. Proceedings of the Indian Academy of Sciences, B. Plant Science 97: 481–503.

Awasthi DD, Singh KP. 1973. Species of the lichen genus *Phaeographina* in Indian subcontinent. Kavaka 1: 87–98.

Baniya CB, Ghimire GPS, Kattel B, Upreti DK. 2001. Lichens in Sikles (Kaski) and Shivapuri (Kathmandu), Nepal. 49–55, in: PK Jha & al. (eds). Environment and Agriculture: Biodiversity, Agriculture and Pollution in South Asia. Ecological Society (Ecos.), Nepal.

Bungartz F, Lücking R, Aptroot A. 2010. The family *Graphidaceae* (*Ostropales*, *Lecanoromycetes*) in the Galapagos Islands. Nova Hedwigia 90: 1–44. https://doi.org/10.1127/0029-5035/2010/0090-0001

Bystrek JL. 1969. Die Gattung *Alectoria*. 17–24, in: W Hellmich, J Poelt (eds). Khumbu Himal 6. München: Universitätsverlag Wagner Ges. MBH, Innsbruck.

Elix JE, Ernst-Russel KD. 1993. A catalogue of standardized thin layer chromatographic data and biosynthetic relationships for lichen substances, 2nd edn. Australian National University, Canberra.

Jahns HM, Seelen EJR. 1974. *Baeomyces*-Funde aus dem Himalaya. 101–108, in: W Hellmich, J Poelt (eds). Khumbu Himal 6. München: Universitätsverlag Wagner Ges. MBH, Innsbruck.

Jia ZF, Lücking R. 2017. Resolving the genus *Phaeographina* Müll. Arg. in China. MycoKeys 21: 13–32. https://doi.org/10.3897/mycokeys.21.11986

Joshi S, Nguyen TT, Dzung NA, Jayalal U, Oh S, Hur JS. 2013a. New records of corticolous lichens from Vietnam. Mycotaxon 123: 479–489. https://doi.org/10.5248/123.479

Joshi S, Jayalal U, Oh S, Koh YJ, Nguyen TT, Dzung NA, Hur JS. 2013b. New species and new records in the family *Graphidaceae* (*Ascomycota*: *Ostropales*) from Vietnam. Lichenologist 45: 599–609. https://doi.org/10.1017/s002428291300025x

Joshi S, Upreti DK, Nguyen TT, Nguyen AD, Oh S, Hur JS. 2015. A new species of *Fissurina* and new records of *Graphidaceae* from Vietnam. Cryptogamie, Mycologie 36: 383–397. https://10.7872/crym/v36.iss4.2015.383

Kalb H, Staiger B, Elix JA. 2004. A monograph of the lichen genus *Diorygma* – a first attempt. Symb. Bot. Ups. 34(1): 133–181.

Kraichak E, Parnmen S, Lücking R, Rivas Plata E, Aptroot A, Cáceres MES, Ertz D, Mangold A, Mercado-Diaz JA, Papong K, Broeck DVD, Weerakoon G, Lumbsch HT. 2014. Revisiting the phylogeny of *Ocellularieae*, the second largest tribe within *Graphidaceae* (lichenized *Ascomycota*: *Ostropales*). Phytotaxa 189: 52–81. http://dx.doi.org/10.11646/phytotaxa.189.1.6

Kurokawa S 1974. *Anaptychia* of the Nepal-Himalaya. 109–110, in: W Hellmich, J Poelt (eds). Khumbu Himal 6. München: Universitätsverlag Wagner Ges. MBH, Innsbruck.

Lamb IM 1966. Die Gattung *Stereocaulon*. 349–352, in: W Hellmich (ed.). Khumbu Himal 1. München: Universitätsverlag Wagner Ges. MBH, Innsbruck. https://doi.org/10.1007/978-3-642-92914-4_10

Lepista Z, Aptroot A 2016. Seven species of *Graphis* from Portugal reported new to Europe. The Lichenologist 48: 259–267. https:// doi:10.1017/S0024282916000153

Lücking R, Chaves JL, Sipman HJM, Umaña L, Aptroot A. 2008. A first assessment of the Ticolichen biodiversity inventory in Costa Rica: the genus *Graphis*, with notes on the genus *Hemithecium* (*Ascomycota: Ostropales*: *Graphidaceae*). Fieldiana Botany 46. 126 p. https://doi.org/10.3158/0015-0746(2008)46[1:AFOTT]2.0.co;2

Lücking R, Archer AW, Aptroot A. 2009. A world-wide key to the genus *Graphis* (*Ostropales*: *Graphidaceae*). Lichenologist 41: 363–452. https://doi.org/10.1017/s0024282909008305

Lücking R, Tehler A, Bungartz F, Rivas Plata E, Lumbsch HT. 2013. Journey from the West: did tropical *Graphidaceae* (lichenized *Ascomycota*: *Ostropales*) evolve from a saxicolous ancestor along the American Pacific coast? American Journal of Botany 100: 844–856. https://doi.org/10.3732/ajb.1200548

Lücking R, Hodkinson BP, Leavitt SD. 2017. The 2016 classification of lichenized fungi in the *Ascomycota* and *Basidiomycota* – approaching one thousand genera. Bryologist 119: 361–416. https://doi.org/10.1639/0007-2745-119.4.361

Lumbsch HT, Kraichak E, Parnmen S, Rivas Plata E, Aptroot A & al. 2014a. New higher taxa in the lichen family *Graphidaceae* (lichenized *Ascomycota*: *Ostropales*) based on a three-gene skeleton phylogeny. Phytotaxa 189: 39–51. http://dx.doi.org/10.11646/phytotaxa.189.1.5

Lumbsch HT, Parnmen S, Kraichak E, Papong KB, Lücking R. 2014b. High frequency of character transformations is phylogenetically structured within the lichenized fungal family *Graphidaceae* (*Ascomycota*: *Ostropales*). Systematics and Biodiversity 12: 271–291. http://dx.doi.org/10.1080/14772000.2014.905506

Mangold A, Elix JA, Lumbsch HT. 2009. *Thelotremataceae*. 195–420, in: PM McCarthy (ed.). Flora of Australia, vol. 57. Canberra & Melbourne: ABRS/CSIRO.

Mangold A, Martin MP, Lücking R, Lumbsch HT. 2008. Molecular phylogeny suggests synonymy of *Thelotremataceae* within *Graphidaceae* (*Ascomycota*: *Ostropales*). Taxon 57: 476–486. http://doi.org/ 10.2307/25066016

Mishra S, Joshi S, Upreti DK, Shrivastava AK. 2016. An updated account on graphidoid taxa from the foot hills of Indian Himalaya. Current Research in Environmental & Applied Mycology 6: 312–327. http://doi 10.5943/cream/6/4/10

Mitchell M. 1974. Die Gattung *Leptogium* sect. *Mallotium* im Himalaya. 121–126, in: W Hellmich, J Poelt (eds). Khumbu Himal 6. München: Universitätsverlag Wagner Ges. MBH, Innsbruck.

Orange A, James PW, White FJ. 2001. Microchemical methods for the identification of lichens. British Lichen Society, London.

Olley L. 2008. Lichens of Nepal Expedition 2007. Bulletin of the British Lichen Society 103: 24–32.

Olley L, Sharma LR. 2013. A provisional checklist of the lichens of Nepal. Journal of the Department of Plant Resources Nepal 35: 18–21.

Poelt J. 1974. Die Gattungen *Physcia*, *Physciopsis* and *Physconia*. 57–99, in: W Hellmich, J Poelt (eds). Khumbu Himal 6. München: Universitätsverlag Wagner Ges. MBH, Innsbruck.

Rai H, Nag P, Khare R, Upreti DK, Gupta RK. 2016. Twenty eight new records of lichenized-fungi from Nepal: A signature of undiscovered biodiversity in Central Himalaya. Proceeding of the National Academy of Sciences, India, B: Biological Sciences 87(4): 1363-1376. https://doi.org/10.1007/s40011-015-0702-y

Rivas Plata E, Lumbsch HT. 2011. Parallel evolution and phenotypic divergence in lichenized fungi: a case study in the lichen-forming fungal family *Graphidaceae* (*Ascomycota*: *Lecanoromycetes*: *Ostropales*). Molecular Phylogenetics and Evolution 61: 45–63. https://doi.org/10.1016/j.ympev.2011.04.025

Rivas Plata E, Lücking R, Lumbsch HT. 2012a. A new classification for the lichen family *Graphidaceae* (*Ascomycota*: *Lecanoromycetes*: *Ostropales*). Fungal Diversity 52: 107–121. http://dx.doi.org/10.1007/s13225-011-0135-8

Rivas Plata E, Lücking R, Lumbsch HT. 2012b. Molecular phylogeny and systematics of the *Ocellularia* clade (*Ascomycota*: *Ostropales*: *Graphidaceae*). Taxon 61: 1161–1179.

Rivas Plata E, Parnmen S, Staiger B, Mangold A, Frisch A, Weerakoon G & al. 2013. A molecular phylogeny of *Graphidaceae* (*Ascomycota, Lecanoromycetes*, *Ostropales*) including 428 species. MycoKeys 6: 55–94. https://doi.org/10.3897/mycokeys.6.3482

Schmidt A. 1974. *Chaenotheca* und *Coniocybe*. 133–143, in: W Hellmich, J Poelt (eds). Khumbu Himal 6. München: Universitätsverlag Wagner Ges. MBH, Innsbruck.

Schiefelbein U, Flakus A, Shipman HJM, Oset M, Kukwa M. 2014. A contribution to the lichen family *Graphidaceae* (*Ostropales, Ascomycota*) of Bolivia. 2. Polish Botanical Journal 59: 85–96. https://doi.org/10.2478/pbj-2014-0017

Shakya PR, Karmacharya N, Kansakar SBS, Shakya RK, Wagle KK, Shrestha M. 2014. Determination of heavy metals in street dust from different types of land-use of Kathmandu Valley, Nepal. Research Journal of Chemical Sciences 4: 82–92.

Sharma LR. 1995. Enumeration of lichens of Nepal. Euroconsult, Biodiversity Profiles Project, DNPWC, Publication No. 3. Nepal Government. 109 p.

Singh KP, Sinha GP. 2010. Indian lichens: an annotated checklist. Govt. of India, Botanical Survey of India. Ministry of Environment and Forest, India.

Singh P, Singh KP. 2017. New combinations in the family *Graphidaceae* (lichenized *Ascomycota*: *Ostropale*s) from India. Lichenologist 49: 527–533. https://doi.org/10.1017/S0024282917000330

Staiger B. 2002. Die Flechtenfamilie *Graphidaceae.* Studien in Richtung einer natürlicheren Gliederung. Bibliotheca Lichenologica 85. 526 p.

Staiger B, Kalb K. 1999. *Acanthothecis* and other graphidioid lichens with warty periphysoids or paraphysis tips. Mycotaxon 73: 69–134.

Staiger B, Kalb K, Grube M. 2006. Phylogeny and phenotypic variation in the lichen family *Graphidaceae* (*Ostropomycetidae, Ascomycota*). Mycological Research 110: 765–772. https://doi.org/10.1016/j.mycres.2006.05.003

Vězda A, Poelt J. 1975. Die Gattungen *Dimerella* und *Pachyphiale*. 127–132, in: W Hellmich, J Poelt (eds). Khumbu Himal 6. München: Universitätsverlag Wagner Ges. MBH, Innsbruck.